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DEPARTMENT OF GEOLOGY AND
MINERAL INDUSTRIES

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Quicksilver in Oregon

By C. N. Schuette

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PREFACE

Oregon in recent years has advanced to second place among the states in production of quicksilver. The value of the metal produced in the State during 1937 was about $380,000, judging by preliminary estimates. Owing in part to the situation in Spain, which is the dominant producer, there has been renewed interest generally in quicksilver production and certain districts in Oregon have received particular attention from quicksilver operators and prospectors.

Quicksilver is one of the "deficiency" or "strategic" war minerals, and its production should be encouraged in all localities where the existence of the mineral is known.

The last field work on quicksilver in Oregon, carried out by a Federal or State agency, was in the summer of 1930. In this the United States Geological Survey cooperated with the State of Oregon and the report of the work was published in 1934 as Bulletin 850, "Quicksilver Deposits of Southwestern Oregon", by the United States Geological Survey. The State Department of Geology and Mineral Industries deemed it expedient to bring the study of Oregon's quicksilver up to date in order to encourage the local industry and so arranged with Mr. C. N. Schuette, Consulting Engineer and an outstanding quicksilver specialist in the West, to do the work. This bulletin is the result. The chapter on metallurgy of the metal should be especially helpful not only in Oregon but wherever quicksilver is produced.

Mr. Schuette's analysis of the economics of quicksilver, the effect of the quicksilver tariff, and his comments on the attitudes of the Federal Agencies, all of which, of course, are his own, are worthy of careful study and consideration not only by producers in this and other states but also by Congressmen and members of the administrative branches.

Some might consider certain of Mr. Schuette's remarks as overcritical. It naturally would be the policy of this Department to grant Mr. Schuette, with his knowledge of the subject and his standing in the industry, a free hand in his preparation of the report.

As a summary of the quicksilver situation in Oregon at the present time, this Department takes pleasure in presenting this report. Later, perhaps next year, it is not unlikely that a study may be made of new or more remote quicksilver occurrences in the State.

EARL K. NIXON, Director

Portland, Oregon
February 1, 1938

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mining with the idea of making it a business should be guided by the 10-year averages of prices.

From the 1921 depression the price of quicksilver picked up as follows:

Year	Average Price
1921	$ 46.07
1922	59.74
1923	67.39
1924	70.69
1925	84.24
1926	93.13
1927	118.16
1928	123.51
1929	122.15
1930	115.01

This is a pickup in price of about $10 per flask per year for eight years after which it dropped through the next depression in 1932. Price recovery from this low has been as follows:

Year	Average Price
1932	$57.93
1933	59.23
1934	73.87
1935	71.99
1936	79.92
1937	90.18

Evidently this is a slower rise than from the last depression. From 1932 to 1933 it was less than $2 per flask. In 1934 the price took a good spurt exceeding the $10 mark by $4.50, but it fell back in 1935 then picked up roughly $10.00 both in 1936 and 1937. Note, however, that recovery started from a higher price in this last depression and that in 1937—the fifth year after the depression low—the average annual price was $90.00. In 1926, the fifth year after the depression low of 1921 the average annual price was $93.13 or roughly the same as for 1937.

The future price of quicksilver depends on the outcome of the revolution in Spain, on other undeclared wars both actual and threatening, and on the recovery of industry throughout the world. Conservative quicksilver miners who keep their costs down and their development work up will no doubt come through the future as safely as in the past, but venturesome operators who gamble on a $100 price must take their chances. We are inclined to admire their enthusiasm.

PART II

The Quicksilver Industry in Oregon

HISTORY

The reverberations of the gold-rush days of '49 in neighboring California were felt throughout Oregon. Settled by hardy, venturesome pioneers, Oregon sent many of its men to the "diggings" and, being experienced woodsmen and used to rough life in the open, many of them fared well and occupied leading positions in those exciting times. So it is no wonder that the quicksilver excitement of California at a later date should find its reflection in Oregon also.

The earliest discovery of quicksilver in Oregon as far as is known was at the Nonpareil and Bonanza mines of Douglas County in 1865. The Nonpareil was developed in 1877 and the Bonanza in 1879. Furnaces were built on both properties, but records of productions are meager.

An early settler in the Rogue River Valley found cinnabar in the "Meadows" of the Gold Hill district of Jackson County in 1878. Some production was made here with retorts in the following years and was sold locally to the placer-gold miners in the vicinity. There is no record of the amount produced. The only record of quicksilver production for Oregon in these years are 65 flasks in 1887, 32 flasks in 1888 and 20 flasks in 1889.

Then there seems to have been a long interval of time in which no quicksilver whatever was produced here. The fact that the ground was cinnabar-bearing was well known however, and transfers of parcels of land around 1900 describe the land as "valuable cinnabar mines". This area now comprises the War Eagle, Chisholm, and Dave Force mines.

The Black Butte mine in Lane County was discovered in the early nineties. A small amount of development work was done and then a 40-ton Scott furnace was built to treat the ore. In 1898, the late W. B. Dennis acquired the property and operated it until 1908. During his regime some 15,000 feet of development work was done and the mine was well-opened up.

The low-grade ore of the Black Butte mine in combination with the very resinous Oregon fir that was used for fuel made

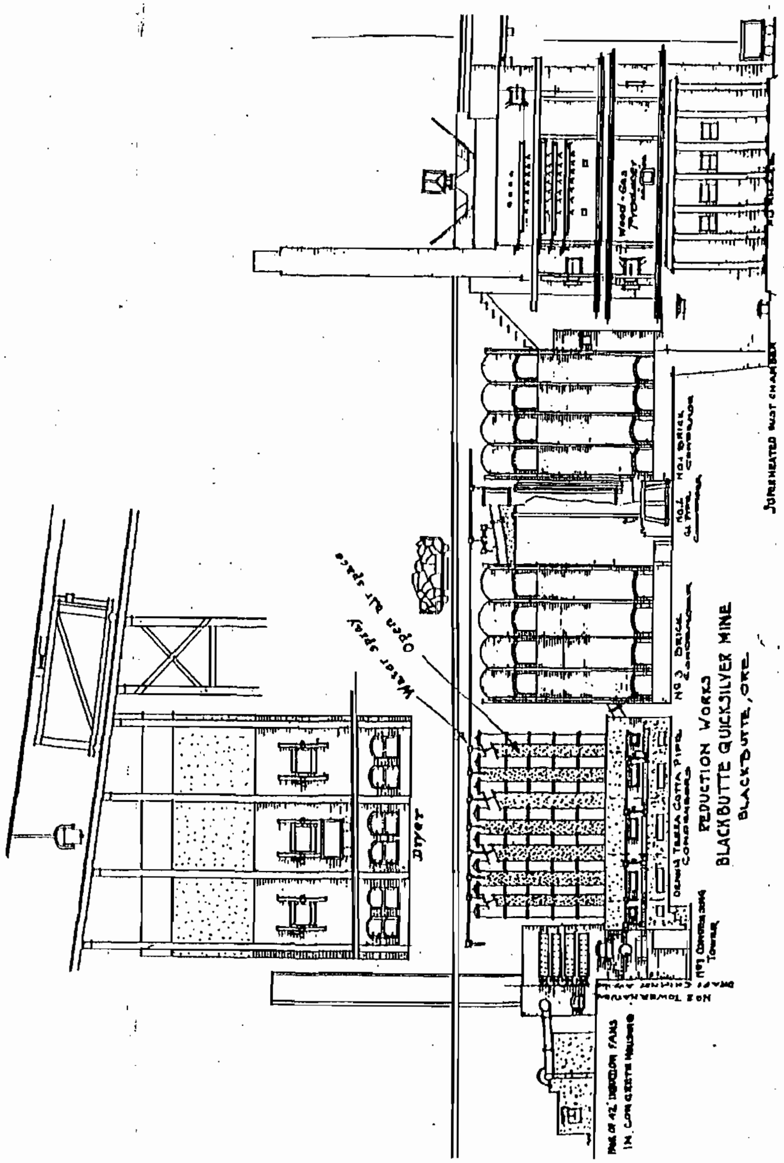


Figure 9—Elevation of old Black Butte plant.

the treatment of the ore anything but ideal. Seeking a remedy for these troubles, Dennis invented and patented a furnace (U. S. Patent No. 833679) with separate roasting zones in which a constant-temperature difference between ore and heating gases could be maintained. This was to increase the capacity by shortening the roasting time. He[18] also invented and patented a wood-gas producer (U. S. Patent No. 893462) in order to obtain a clean fuel from Oregon fir.

A small, experimental, Dennis furnace was built at Black Butte. It was operated for a few months in 1905 and aroused great interest. The roasting time was shortened from 24 to 4 hours, soot was completely eliminated and there was a considerable saving in fuel.

Lack of funds (the price of quicksilver averaged $36.22 in 1905) prevented the building of a full-size Dennis furnace. However, a down-draft wood-gas producer was built into the old Scott furnace and a tile pipe condenser system was added to the old brick condensers. This gas producer increased the capacity of the Scott furnace from 30-36 tons to 49-51 tons per day on practically the same fuel consumption.

This account of the Black Butte experimental work which the author obtained from Mr. Dennis himself many years ago is of great historical interest. The ideas that were worked out here were well in advance of the times and similar methods of using wood-gas producers were worked out in Europe at a much later time. Tile pipe condensers on the general principles developed by Dennis were used in the United States 20 years later.

Thus Oregon contributed to the general fund of knowledge on quicksilver metallurgy long before it had become an important producer of the liquid metal. An elevation of the old Black Butte Plant is given in Fig. 9.

The quicksilver of the Prineville District is first mentioned in 1906 when a production of three flasks was recorded for the Almaden Gold and Quicksilver Company at Howard in Crook County.

In 1908 mention is made of work being done by the Scotia Development Company near Drew.

[18] William B. Dennis: Shortening the Roasting Period for Mercury Ores. E. & M. J. July 17, 1909, pp. 112-116.

No production is recorded for Oregon from the end of 1909 to the end of 1914. From 1887 to 1915 the total production of Oregon did not much exceed 1,000 flasks.

The next productive period in Oregon was during the World war. In this period from 1915 to 1920 inclusive the Black Butte mine was in production with its Scott furnace plant. The War Eagle mine operated by the Ranier Quicksilver Company produced with Johnson McKay retorts and later with a Scott furnace. Smaller mines and prospects also produced some metal and the total recorded production for the above mentioned period was about 1,860 flasks.

Then the activity in quicksilver mining died down again and only scattered production was reported to 1924.

By checking all available information from all sources it would seem that the total production of Oregon to the end of 1926 was close to 3,000 flasks of quicksilver.

In 1927 a new era of steady and continuous quicksilver mining set in for the state of Oregon. The price of quicksilver was over $100 per flask that year and it stayed above $100 per flask for the three subsequent years also. Aided by a high price the business of quicksilver mining in Oregon got off to such a good start that it weathered the recent depression and has produced an average of $275,000 worth of quicksilver each year for the last 11 years or a total for that time well over $3,000,000.

An interesting comparison of these first 10 years of steady Oregon production with that of the first 10 years of Texas production is given below:

TABLE 6

OREGON		TEXAS	
Year	Flasks	Year	Flasks
1927	2,082	1899	1,000
1928	3,759	1900	1,800
1929	3,657	1901	2,932
1930	2,919	1902	5,319
1931	5,011	1903	5,029
1932	2,523	1904	5,336
1933	1,342	1905	4,723
1934	3,460	1906	4,761
1935	3,456	1907	3,686
1936	4,126	1908	2,382
	32,335		36,968

In flasks produced, Texas was some 12½ per cent ahead of Oregon, but in value of the product the output of Texas was roughly only one-half or about 1½ million dollars to about 3 million dollars for Oregon.

GENERAL GEOLOGY OF OREGON

Before going into discussion of the various quicksilver districts of the state, it seems desirable to review briefly the general geology of Oregon.

Oregon is divided into two parts physio-graphically by the Cascade Range which extends across the state from north to south. It divides the state into a humid western and an arid and semi-arid eastern region, just as the Sierra Nevada farther south separates humid California from arid Nevada.

Speaking very generally, west of the Cascades the geology of Oregon is largely that of sedimentary rocks while east of them the igneous type of rocks predominate.

The northeastern part of the state is largely occupied by Snake River basalts which may be correlated with Columbia River basalts.

This northeastern area is bounded on the south by a mountainous uplift referred to as the Blue and Ochoco Mountains, running from the Idaho Rockies westward toward the Cascades through the east center of the state. The Columbia River basalts are Miocene in age, but in this uplifted area older rocks have been exposed by erosion.

South of this area, in the southeast part of the state, the geology is more nearly that of the Great Basin type found in Nevada although lava flows like those of the Columbia River basalts are found well down into Nevada.

The Willamette Valley in northwestern Oregon lies between the Cascade and Coast Ranges. The Cascade Range of Oregon continues south into California, where it is referred to as the Sierra Nevada. However, the Oregon Coast Range has its southern terminus about at the Coquille river, but is called the Coast Range again at points some distance south of the Oregon-California line. Occupying the territory west of the Cascades and extending to the coast in southern Oregon and northern California we find the Klamath Mountains.

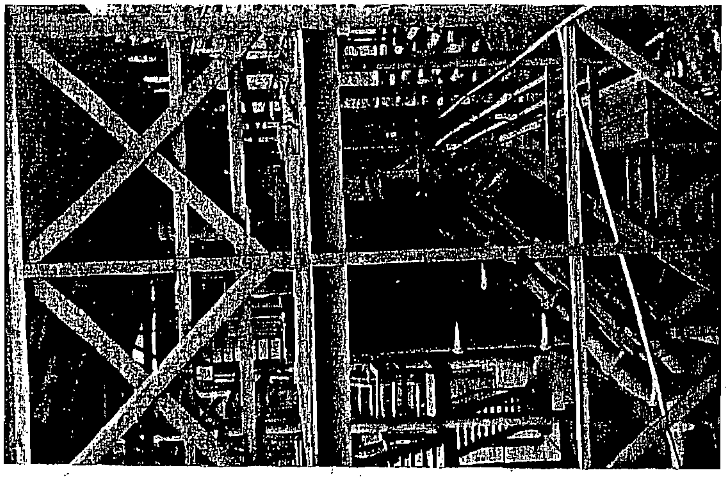


Photo No. 29—End view of the Bonanza Condenser System showing the wash-down platforms.

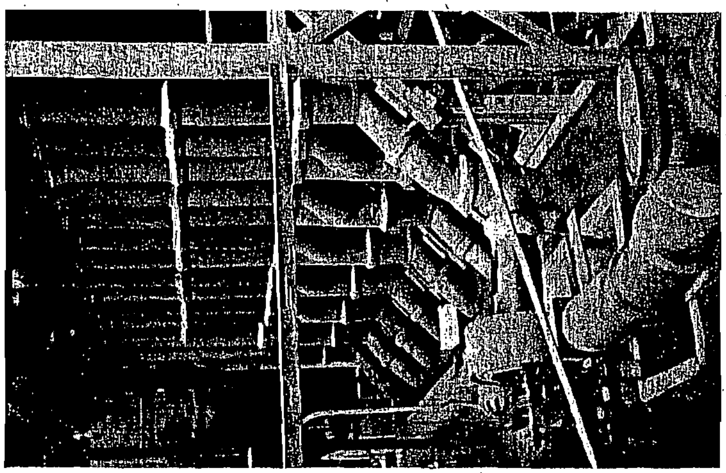


Photo No. 28—Exhauster and collecting trough of the Bonanza Condenser. The water in the trough seals the bottom of the gathering pipes.

The property has living quarters for the superintendent, but the crew of 12 to 14 men lives on neighboring ranches or in Sutherlin so that no boarding house is necessary. Wages are $3.20 for roustabouts, $4.00 for muckers and furnace men and $4.50 for miners. Haulage and fuel costs are low and with such generally favorable conditions the Bonanza Mine should become one of the steady producers of Oregon.

Black Butte-Elkhead District

This district comprises parts of two counties, Black Butte being in Lane and Elkhead in Douglas County. From U. S. Highway 99 the district is reached by going east from Yoncalla or south from Cottage Grove.

Geologically, this district lies at the junction of the Coast Range and the Cascade Range at the head of the Willamette Valley. Drainage from the district is both north into the Willamette river and west into the Umpqua river. The Calapooya Mountains which run northwest through the district form the divide between the drainage basins. Elevations in the district range from around 1,000 feet in the valleys to 2,000 and 4,000 feet on the Calapooya mountain peaks.

The general geology of the area as well as the mine geology is well described in U. S. G. S. Bulletin 850. Briefly, an elongated anticlinal dome with a northeast trend and some 12 miles wide and dipping 10° to 18° is developed in the Umpqua formation in this district. A normal fault striking northeast and having a displacement of several hundred feet is found in the Black Butte Mine. Other faults of smaller throw also are normal and strike northeast.

Uncomformably on the Umpqua formation lies a series of volcanic conglomerates, pyroclastic rocks and lavas which constitute the Calapooya formation. Both the Umpqua and the younger Calapooya formation are intruded by basalt and diabase.

The core of the anticlinal dome is amygdaloidal lava and the flanks and top are shale and sandstone. During the flexing of the rocks when the anticline was formed, differential movement occurred between the lavas and overlying sediments. At the Elkhead mine where the dip of the east leg of the anticline is locally as steep as 30° to 50°, this differential movement fractured the tuffaceous member just above the amygdaloidal lava. These fractures were the source fractures for the mineralization of the Elkhead mine.

The Calapooya formation had not been laid down when this anticline formed but came much later after erosion had leveled off the top of the anticline.

BLACK BUTTE MINE USBM

This mine is just 17 miles from Cottage Grove by a good hard-surfaced road often greatly cut up by the abuse to which it is put by overloaded lumber trucks.

The early history of this mine has been related. In 1927 a 4 by 60 foot rotary kiln plant was installed and production has been continuous since then.

The mine is located in the northwest ¼ of Sec. 16, T. 23 S., R. 3 W., on a steep-sided butte rising 1,650 feet above the valley floor. This "Black Butte" is composed of andesitic lavas and breccias of the Calapooya formation. Thermal waters have altered and silicified these rocks. At the outcrop these altered rocks weather to a characteristic "brown iron rib" appearance. Being silicified and therefore hard they have withstood erosion and form a series of bold crags along the top of the Butte.

The channel through which the thermal solutions came up was a fault and shear zone striking north 69° west and dipping some 65° northeast.

A post mineral fault presenting a beautifully hard smooth surface forms the footwall of the ore mined in the upper levels. This was probably a recurrent movement along the original fracture as the greatest mineralization which forms the ore in the shear zone is close to this fault.

Plate 9 of U. S. G. S. Bulletin 850 shows a plan of the mine levels and a longitudinal section of the workings showing the stoped areas. Since 1930 a great deal of new ground has been stoped, as shown in Figs. 20-A and 20-B.

In the last two years most of the ore has come from the west end of the mine on the 5, 4, and 3 levels. This has averaged some 3.5 lbs. per ton. Unmined ore still extends for 130 feet farther west with backs of some 100 feet to the surface but being near the surface it is wet work mining it in winter.

In November, the 9 level was being prepared for mining between the Smoky stope and the Huckins stope. This is a block of ground some 160 feet long and between levels 6 and 9. From 6 up this has been mined out. The block from 6 to 9 is expected to run 3.5 lbs. quicksilver per ton.

On the 9 the ore lies some 45 feet under a basalt dike. On the 11 level on the west end where mining was carried on a year ago the ore is on the hanging instead of the footwall and up against the basalt dike. 250 feet below the 11 the ore is still under the dike but only runs 2 lbs. per ton.

In the Dennis Creek Tunnel, the lowest level in the mine there are 2 dikes, one of them in the hanging.

On 3 level the West Crosscut was run to the footwall and 3 was driven on the footwall and stoped from there to the surface, west of the crosscut. East of the West Crosscut a block of 3 lb. ore is left that is 10 to 15 feet wide and runs 50 feet to the surface.

Altogether, there is ore for a length of about 300 feet along the strike, left between the Middle and East Crosscut on this level, and 150 feet along the strike between the West and Middle Crosscuts. This ground gets too wet to be worked in winter.

On 3 level, crosscuts into the footwall showed spots and bunches of 7 lb. ore some 20 feet under the footwall.

The East 5 level is all prepared for stoping for a length of 500 feet and from the 5 level to the surface. It is expected to run 3 lbs. Diamond drilling on this level showed ore some 80 feet in the footwall. On the hanging a diamond drill hole cut a basalt dike and this now furnishes a good stream of cool drinking water. The ore in this east end should extend down to 6 but this level has not yet been run out under it.

9 level runs under the footwall and a basalt dike is under it. The "Copenhagen" stope some 200 feet in from the surface shows soft, greatly altered, and decomposed rock with streaks of bleached white clay-like masses in it. When panned this showed small amounts of cinnabar, meta-cinnabar, and native quicksilver. The ore "makes" quite a streak of high-grade just under a fault gouge but is too wet, sticky, and messy to be handled.

Photo No. 30—Black Butte Mine. Gasoline locomotive bringing a train of ore to the plant from the Dennis Creek Tunnel.

11 level is connected with the Dennis Creek Tunnel by a 12 by 6 raise some 650 feet long on the incline. Vertical distance between these levels is 413 feet.

The Dennis Creek Tunnel is 7 by 9 in section and was driven 60 feet into the footwall. No definite hanging was discernible. The ore zone was found some 250 out from the footwall. On the footwall are some 6 to 7 feet of calcite and it goes under the footwall in two or three places. Some of this calcite was mined, ground and sold for agricultural purposes.

The ore on Dennis Creek Tunnel level is very low-grade and spotty as thus far developed.

Ore can be dropped to this level through the raise from 11 and is then mule-trammed out in 5-car trains of 1-ton cars. These cars are dumped on a grizzly over an 800-ton storage bin. Oversize from the grizzly goes through a 12 by 20 Blake Crusher into the bin.

From this bin the ore is taken to the plant by gasoline locomotive in trains of 5, 1-ton side dump cars illustrated in Photo 30.

The mining method is shrinkage stoping and has been described in detail by Elmer[20] and Schuette[21].

The individual stopes are 20 to 40 feet wide and several hundred feet long. Occasional pillars of low-grade rock are left. The ground is hard and stands open indefinitely and the dip is steep enough to let the ore flow freely. Chutes are 25 feet apart with 3 by 2½ foot openings. At present with only one furnace in operation, 11 men in the mine keep the plant supplied with ore and do the necessary development work. Wages are 50, 55 and 60 cents per hour at present. This is some 50 cents per day less than in 1930 when the price of quicksilver was much higher.

From 9 level the ore is trammed by mule train to a jaw crusher set over a fine-ore bin from which an aerial tram delivers it to the 70-ton plant bin below. Photo 31 shows the tram which consists of 110 buckets on a ⅞ inch cable, each bucket carrying 90 lbs. The use of this tram may be discontinued in the near future and all ore will then come out through the Dennis Creek Tunnel as described above.

[20] William W. Elmer: Mining Methods and Costs at the Black Butte Quicksilver Mine, Lane County, Oregon. U. S. Bureau of Mines Information Circular 6276, 1930.

[21] Schuette, C. N. Quicksilver, U. S. Bureau of Mines Bulletin 335, pp. 37-43.

Photo No. 31—Black Butte Mine. Aerial tram which brings ore down from No. 9.

The basalt dikes in the mine are very interesting and relatively little seems to be known concerning them. They may be associated with the ore deposition here as similar dikes certainly are associated with it in other mines. If so, a crosscut or raise into the hanging through the dike, say, on 9 level might find a parallel ore body at some distance on the other side of it.

Little if any prospecting has been done outside the main workings though lately some development has been proposed on a seam of high-grade ore that outcrops near the mouth of Dennis Creek Tunnel on the opposite side of the creek. A small tonnage of high-grade ore was minded from this prospect by a leaser. Across the creek, that is, on the side where the railroad is, some ore has been stoped in cuts and underground but it was said that this was too low-grade to pay.

The Black Butte Plant: A plan and elevation of the original rotary furnace plant at Black Butte is given in U. S. B. M. Bulletin 335. This was placed in operation late in 1927 and the second kiln was added in 1929.

The original plant had a large concrete dust chamber followed by the tile pipe condensers of 15-inch pipe. Twelve strings of this pipe, each 20 feet long, and inclined at 45° to aid cleaning constituted the cooling unit. This was followed by a wooden chamber and from there a long stack flue of 15-inch tile pipe led to the stack. Connection at the top of the condenser pipes was by a clumsy wooden box and at the bottom the pipes headed into small concrete chambers. Water sprays in the pipes served to collect dust in the form of quicksilver laden mud. Draft was induced by an air injector at the base of the stack. The fire box of this kiln was of concrete, lined with firebrick. This plant used a helical screw feeder on the furnace.

The new unit of the plant added in 1929 was another 4 by 60 kiln but had a dust chamber and firebox inclosed in sheet iron and two cyclones to remove the dust. The kiln was fed with a shaking feeder. The condenser system of the new unit is shown in Photo 32. It was similar to that of the first one but was followed by large wooden barrels the top of one of them being visible in the photo. This unit had its own stack flue and stack as shown in Photo 33.

The new unit was not as satisfactory as the old one and has operated only about three years since it was installed. The

original unit has been improved by placing a Sirocco Dust Collector between the dust chamber and condenser to eliminate the dust and both condenser systems are being used with the one furnace. This is a good practical illustration of the fact that in treating low-grade ore a larger condenser system is needed than when treating high-grade ore. Photo 34 shows the Sirocco Dust Collector installed in the original plant.

Photo 35 shows a general view of the plant from the railroad coming from Dennis Creek Tunnel, and the aerial tramline from 9 can be seen as well. Up high at the left is the new stack, and the stack flue of the original stack runs through the foreground. The original set of condensers is in the center and at the right center a corner of the new condenser can be seen.

The kilns are lined with 5-inch kiln blocks. The helical screw feeder is best for the Black Butte ore as the clay in it causes it to stick in the shaking feeder. The screw feeder is very sturdily built and can crush any ordinary rock that tends to stick it.

Gas temperature in the dust chamber is 800° F. A fan draws about one-third of the gas stream through the Sirocco Collector into the small original condenser system and another fan draws the other two-thirds of the gas through the two cyclones into the larger new condenser system.

When running one kiln about 75 tons per day are furnaced. When two kilns are operating, they treat about 65 tons each.

The Sirocco Dust Collector collects about 1½ tons of dust and the two cyclones collect about one ton of dust per 24 hours.

Here as in other plants the dust nuisance has been eliminated by use of the Sirocco Collector and such little mud as is collected is dried, hoed and returned to the furnace.

Fuel consumption is about 10 gallons per ton. This is partly due to the high moisture content of the ore and partly because the feed is fairly coarse and it takes more fuel to heat a large lump of ore than a small one. Finer crushing rapidly runs into money and so most plants strike a happy medium between increased cost of finer crushing and higher fuel consumption for coarser ore.

Wages in the plant are 45 and 47½ cents per hour. There are two men in the plant on night and graveyard shifts and on

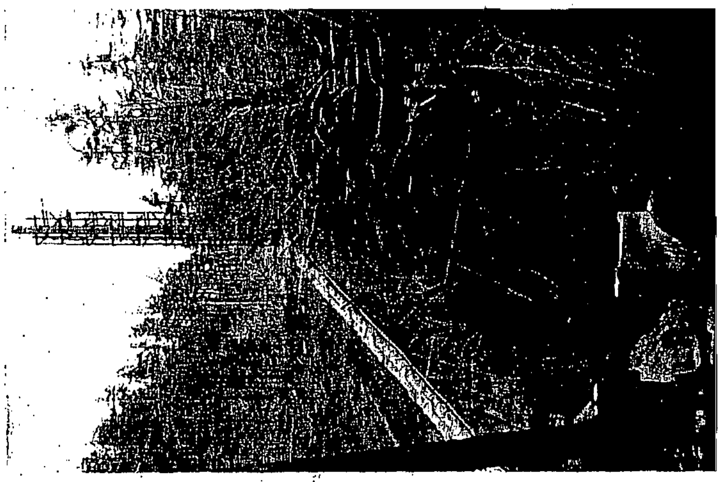


Photo No. 33—Stack and Stack Flue, Black Butte.

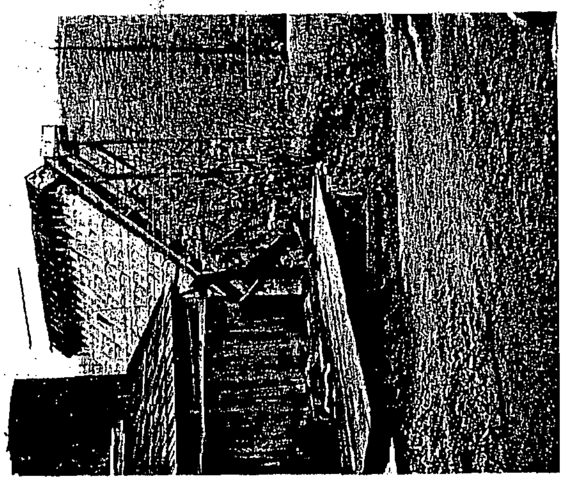


Photo No. 32—Condenser System, Black Butte.

day shift there are two men and two helpers and one mechanic. The tramway brings down the ore on one shift. The crew aside from the 11 men in the mine totals 15 men.

Black Butte is an outstanding mine in many ways. The average grade of the ore from which its production has come is about 3 lbs. of quicksilver per ton on recovery. This makes it the outstanding low-grade producer of the United States quicksilver industry. This is even more creditable when it is remembered that the ore is mined by underground methods and not by open-cut operations as one might expect for the No. 1 producer from low-grade ore.

Besides this it is the largest quicksilver mine of Oregon in point of total production to date. Taken from all available sources, it would seem that the total production in three active periods was as follows:

Prior to 1910	911 flasks
1916-1919	1,271 flasks
1927-1938	11,060 flasks
Total to 1938	13,242 flasks

OTHER PROSPECTS

U. S. G. S. Bulletin 850 on plate 7 shows 4 other areas of altered rock similar to that on Black Butte. These have been prospected for cinnabar without tangible results. They are called Hobart Butte northwest of Black Butte, Sullivan Prospect on the north side of East Garoutte Creek, and Bald Butte and Cinnabar Mountain on the south.

ELKHEAD MINE

This mine is located in the northeast ¼ of Sec. 21, T. 23 S., R. 4 W. about six miles east of Yoncalla. It was discovered in 1870 and is said to have produced in those early days although there is no record of such production. In 1895 a small Scott furnace was built but again there is no record of any production. U. S. G. S. Bulletin 850 on Plate 12 shows a plan and section of the mine, and Plate 13 shows the geology of the mine area.

The rock alteration along the ore zone is similar to that at Black Butte forming the typical iron ribs. The formation strikes northwest and the dip is southeast. The lowest formation is an amygdaloidal basalt. On this lies a tuffaceous sandstone and

SUPPLEMENT

Quicksilver in Oregon

By C. N. SCHUETTE

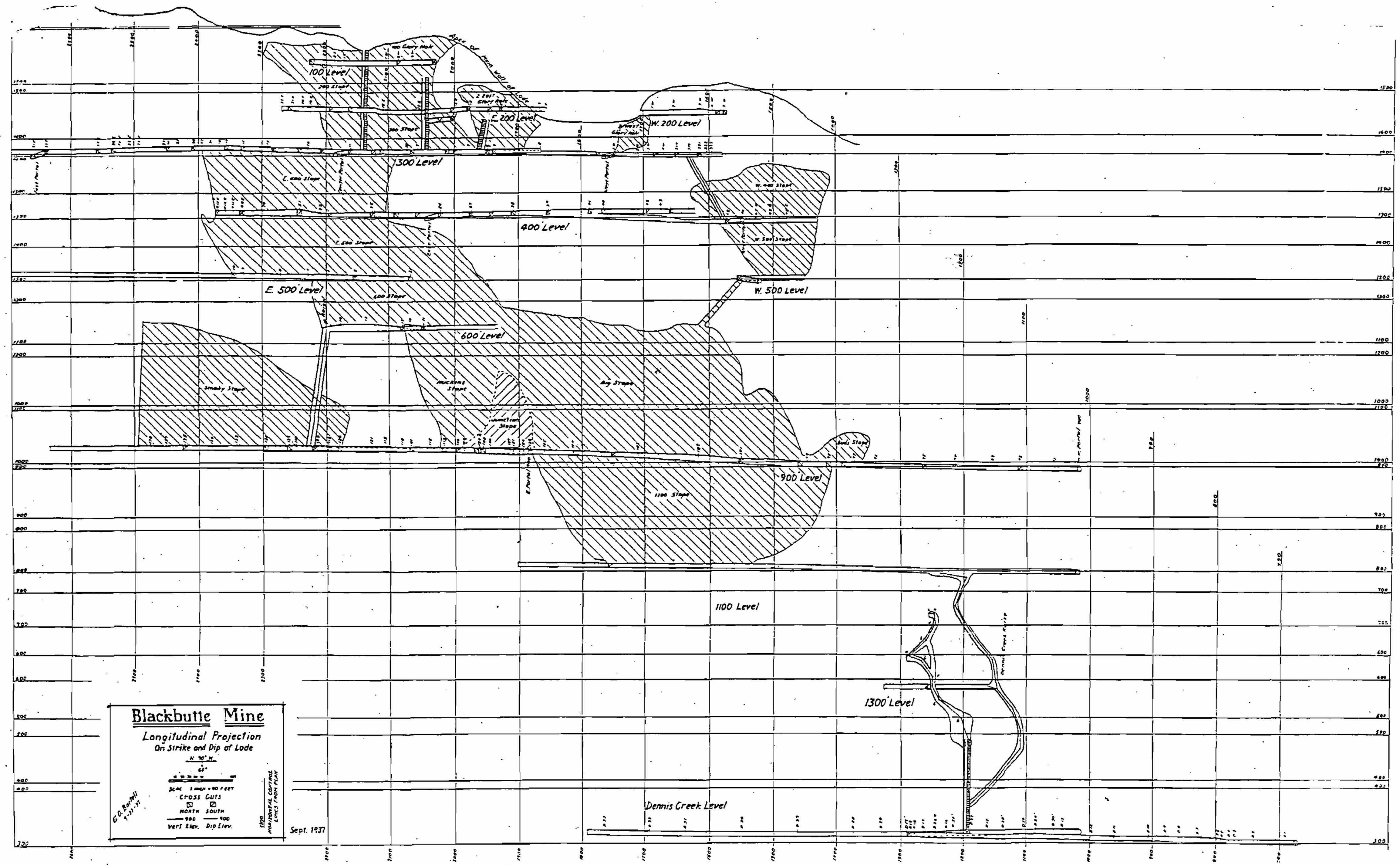


Figure 20-A—Black Butte Mine—Longitudinal projection.

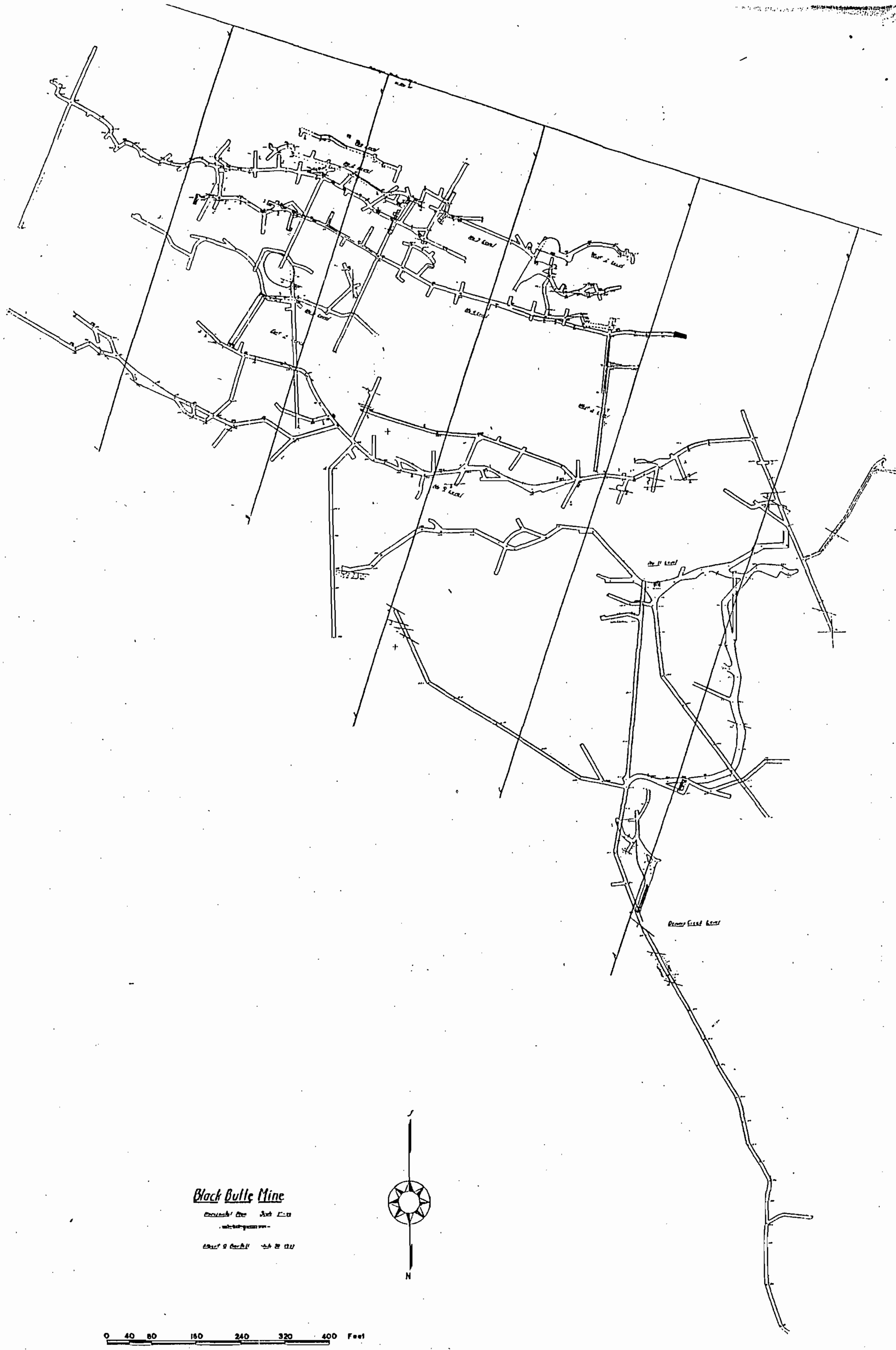
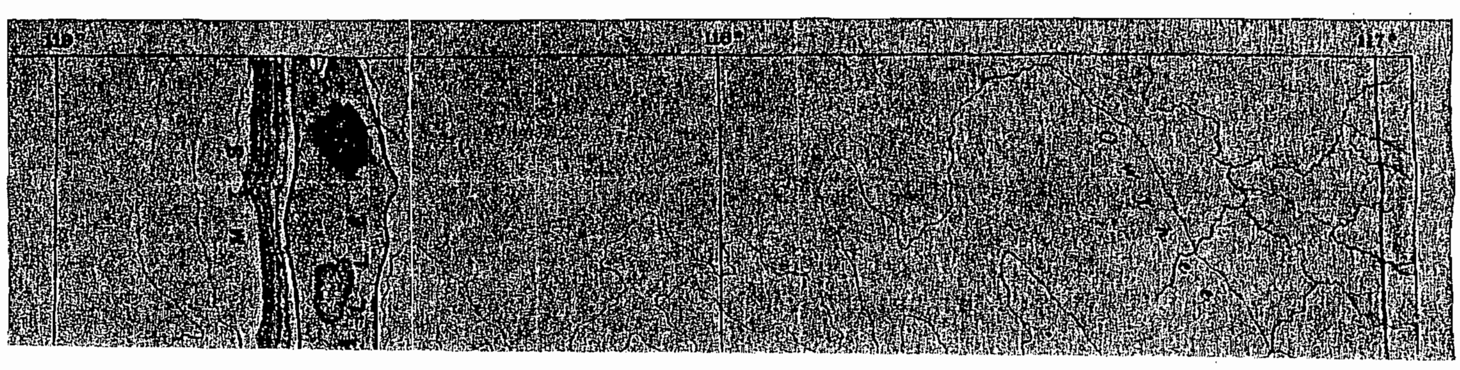


Figure 20-B—Black Butte Mine—Horizontal Plane.



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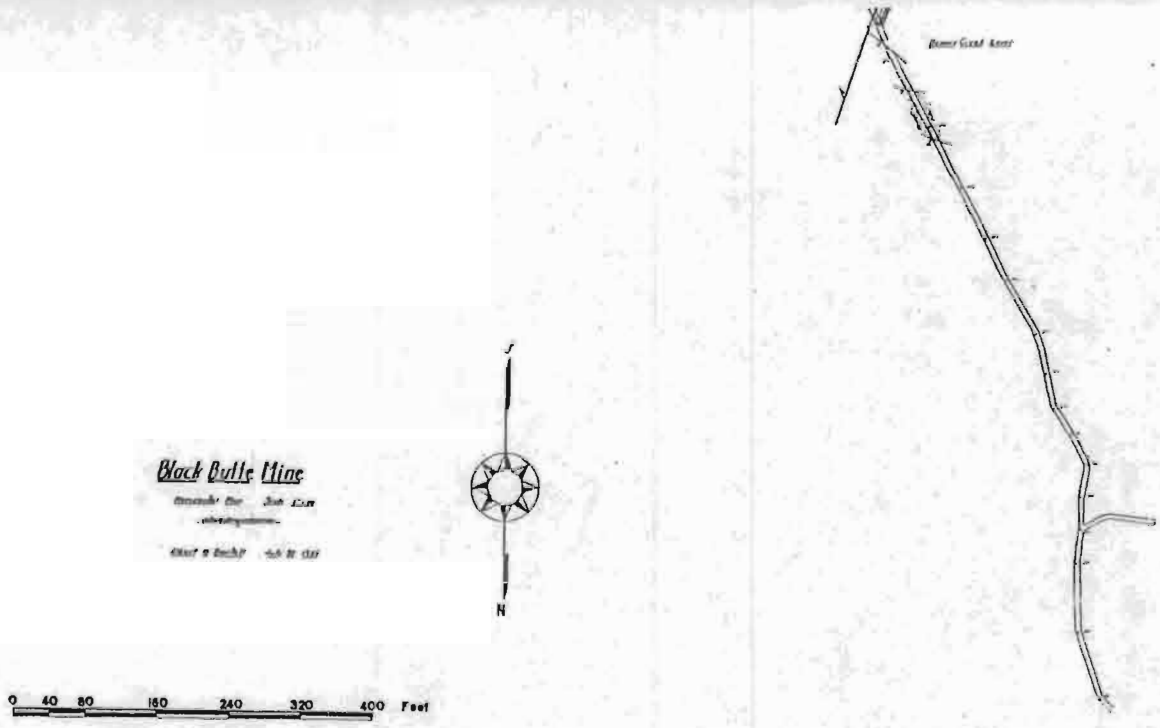

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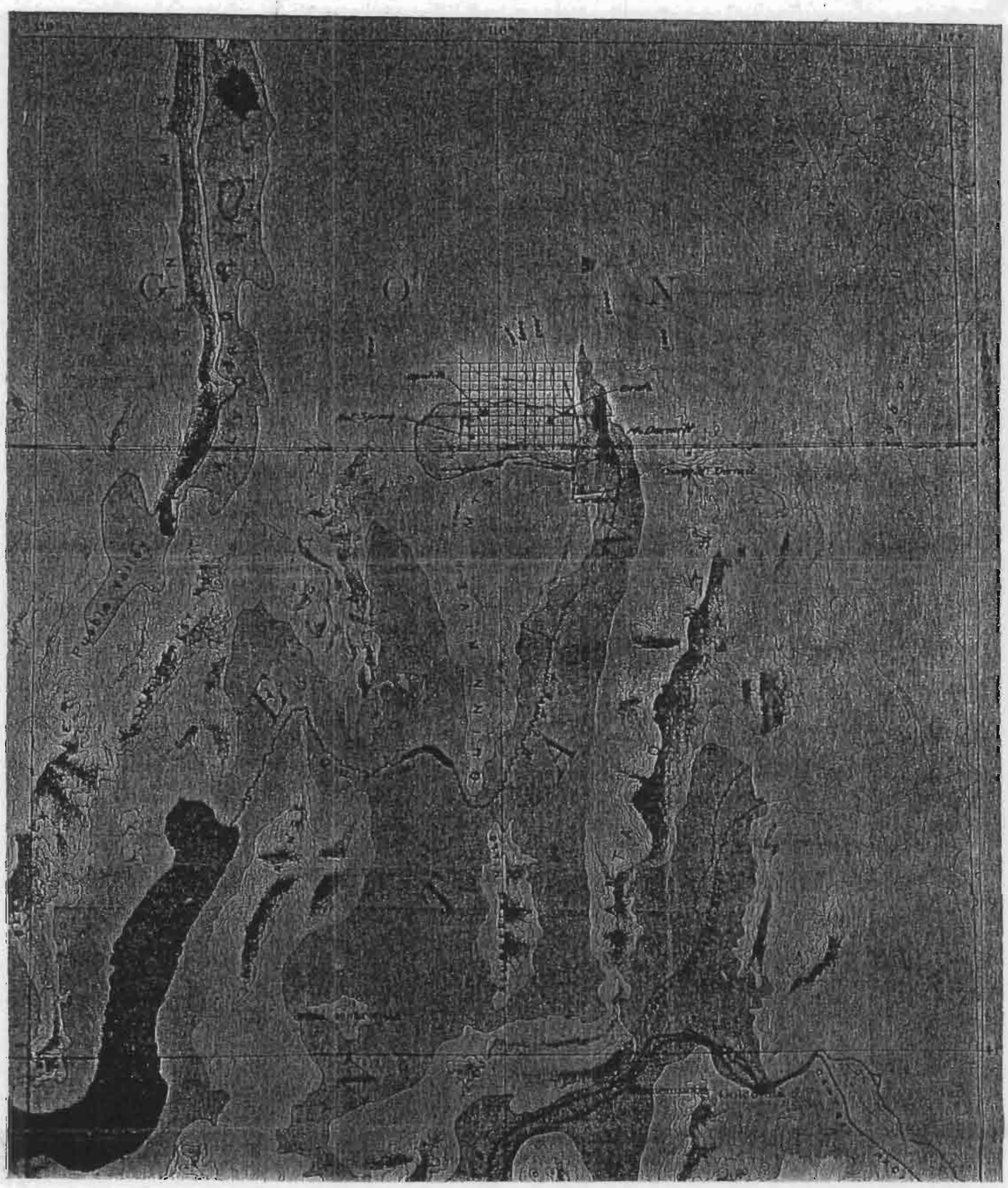

Figure 21—High-water stage of Lake Lahontan.